PROPOSED RESIDENTIAL BUILDING AT WARREN ROAD, MYLAPORE, CHENNAI.

DESIGN BRIEF REPORT FOR STRUCTURAL SERVICES

Client:		LANCOR
Structural Consultant:		BURO ENGINEERS (I) PVT LTD Civil & Structural Consultants New No.31, (old No. 14), Besant Avenue, Adyar, Chennai 600 020.

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1.0 PROJECT INFORMATION

1.1 Introduction:

This Design Brief Report (DBR) is for the Proposed Residential Building (1 Basement+Stilt+13 Floors) at OLD NO.5, NEW NO. 15, BAKTHAVATCHALAM ROAD (WARREN ROAD), MYLAPORE, CHENNAI-600004.

This report provides the information on Codes of Practice, Design loading, Material Strength considered for the Design and Analysis of the building. In addition this report includes Structural system, Foundation system, Method statement of structural analysis which will be adopted for design and analysis for the building.

1.2 Facilities:

The proposed Residential Building the sub structure levels Basement to provide car parking facilities and other levels are mainly residential space. The floor facilities are as follows

2.0 STOREY INFORMATION

Story	Facilities
Basement	Car Parking, Pump room, UG sump
Stilt Floor	Car parking, Lobby, Electrical Rooms, Toilets.
1st Floor	3 residential units
2nd Floor	Multipurpose Hall & 3 residential units
1st to 12th Floor	4 residential units
13th Floor	Swimming Pool, Gym & 2 residential Units
Terrace	Open terrace, OHT & LMR

2.1 Floor to Floor Height:

Basement to GROUND FLOOR	3.70m
Ground floor TO 1ST FLOOR	3.0m
1ST FLOOR TO ROOF	3.0m

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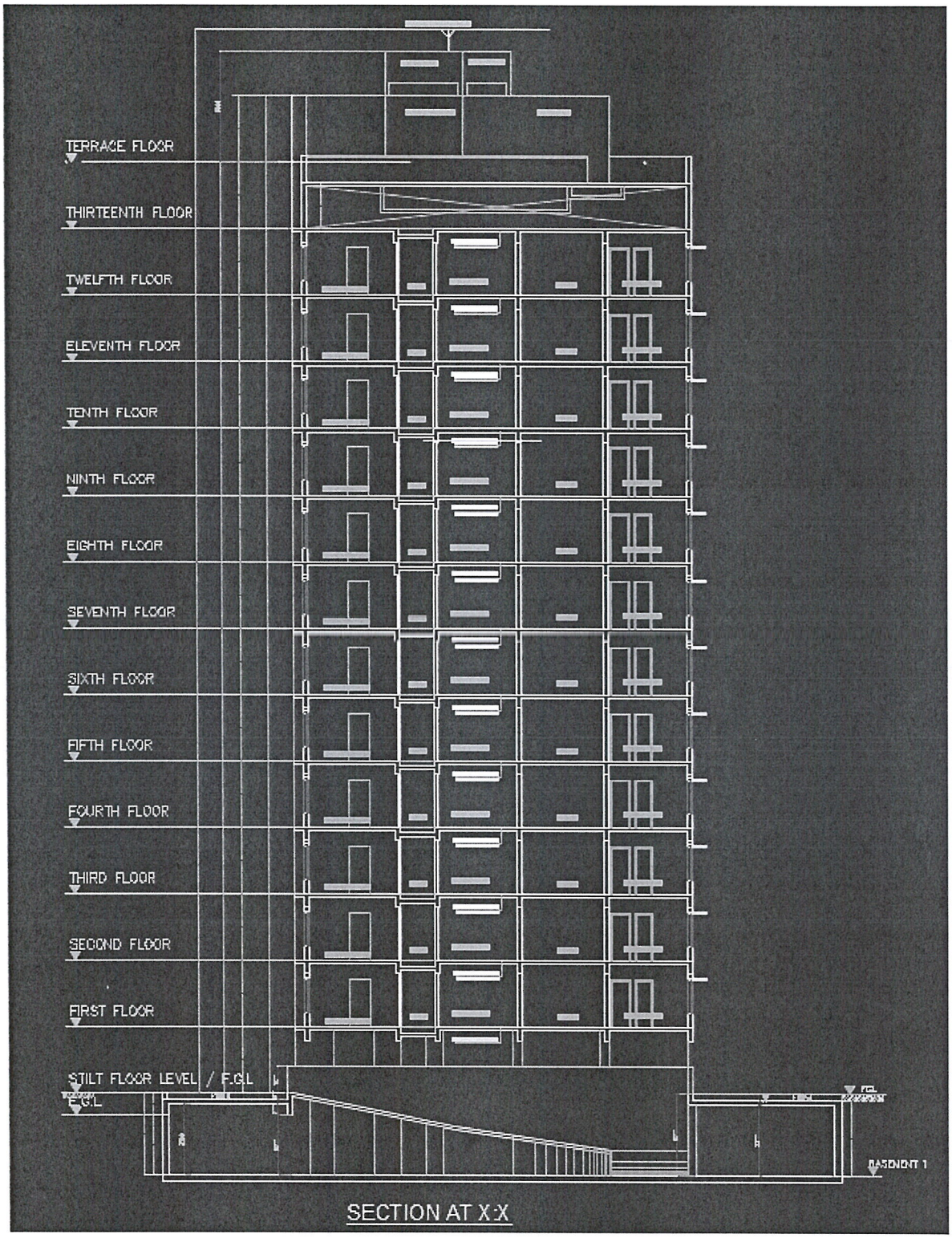

SECTIONAL VIEW

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3.0 SITE DISCRIPTION

3.1 Ground Condition:

We have reviewed the reports to understand the stratigraphy and ground conditions at the site provided by M/s. Geo Engineering Consultants, Chennai.
The general geological sequence identified by the record of the 2 borehole as in dated during month of November 2024 is as follows:

Stratum	Depth from Existing ground level
Silty Clayey Fine Sand	1 to 1.25m
Silty Fine Sand	1.25 to 4m
Silty Fine Sand	4 to 5m
Silty Fine Sand	5 to 9m
Completely weathered Rock	9 to 10.50m
Highly weather Rock	10.50 to 15m

4.0 CODES OF PRACTICE

The relevant Indian Standard codes below are followed.

4.1 Code, Standards and References:

All design of structures shall comply with the requirements specified in the following.

a. Relevant Indian Standard Codes of Practice
b. National Building Code.
c. Local Building regulations.
d. Other relevant International codes where required.

All applicable latest edition of codes and standards will be referred and adopted in the analysis of structures and the design and detailing of structural members. All structural elements design shall be carried out primarily based on. Indian Standards and Codes with latest revision, with amendments if any, as on date.In addition, other international codes and standards shall also be referred when required and relevant.

In the analysis, design and detailing of the building, the following Indian Standard codes of latest amendment will be used.

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CODE	DESCRIPTION
IS 875(Part 1) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures - Unit weights of buildings materials and stored material
IS 875 (Part 2) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures - Imposed Loads
IS 875 (Part 3) 2015	Code of practice for Design Loads (other than earthquake) for buildings and structures - Wind Loads
IS 875 (Part 5) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures - Special Loads and load combinations
IS 456 - 2000	Code of Practice for Plain and Reinforced Concrete
IS 16700 - 2017	Criteria for Structural Safety of Tall Concrete Buildings
IS 1343 - 2012	Code of Practice for Prestressed Concrete
IS 1893 - 2016 (Amendment-2)	Criteria for earthquake resistant design of structures
IS 4326 -2016	Code of practice for Earthquake Resistant Design and Construction of Buildings
IS 3370 - 2009	Code of Practice for Concrete structures for the storage of liquids
IS 1904-1995	Code of Practice for design and construction of Foundation
IS 1905-2021	Code of Practice for Structural use of Unreinforced Masonry
IS 1080 - 1985	Code of Practice for design and construction of shallow Foundation
IS 2950 - 1981	Code of Practice for design and construction of

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	Raft Foundation
IS 800 – 2007	Code of practice for General Construction in steel
BS 8110 : 1997	Plain and reinforced concrete-code of practice(British standard)
ACI 318	Plain and reinforced concrete-code of practice (American standard)
IS 13920: 2016	Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces
SP24	Explanatory Hand book on Indian standard code of practice
SP34	Handbook on concrete reinforcement and detailing

5.0 COVER AND FIRE RATING

Cover to reinforcement considered for various elements

Structural element	Exposure condition	Fire rating in hours	Cover	
Pile	Severe		75 (Bottom)	75 (Top)
Basement wall	Severe		45 (Soil side)	30 (Building side)
Column		2	40	
Shear wall		2	30	
Beam (Simply supported)		2	40	
Beam (Continuous)		2	30	
Slab (Simply supported)		2	35	
Slab (Continuous)		2	25	

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6.0 STRUCTURAL SYSTEM

Floor system: The structural Floor system for the super structure is RC Beam with RC slab.

Lateral load resisting system: Ductile Shear Wall System

7.0 FOUNDATION & BASEMENT SLAB

The following are inferred from the Geo-technical investigation report.

A total of 2 boreholes were terminated after drilling approximately 30m depth. Encountered layer was in the form of Soft rock. The N value recorded at this depth is more than 100.

The report has also stated the ground water table is encountered at 2.1 m from EGL. We have considered for basement wall and the Stitch slab design water head of 1.0m from the EGL.

For the building adopted foundation system is pile foundation, with reference to Geo Engineering Consultants & Services (P) LTD soil investigation report the recommendation of safe carry capacity of bored cast-in-situ piles are as follows and the same capacities are considered in foundation design,

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Table:- 4.1 Recommended Safe Load Carrying Capacities of Bored Cast-in Situ Piles								
Sl.No	Reference Bore hole No.	Length of Pile below E.G.L	Assumed Length of Cut-Off Below E.G.L	Length of Pile below Cut-off	Dia.of Pile in (mm)	SAFE LOAD CARRYING CAPACITY (kN)		
						Vertical Load Carrying Capacity	Pull Out Capacity	Lateral Load Carrying Capacity
1	BH-02	29.0	4.0	25.00	500	1100	800	45
2					550	1200	900	50
3					600	1400	1000	55
4					650	1600	1100	60
5					750	1800	1200	70
6					800	2000	1300	80
7					900	2300	1500	90

8.0 MATERIAL GRADES

Materials specified will confirm to the latest edition of the relevant Indian Standards. Specifications for materials will include for sampling and testing as stipulated in the design standards. Detailed material specifications will be included in the Technical specifications.

8.1 Concrete

Durability provisions for concrete structures shall be as per 'Severe' conditions of environment in accordance with IS 456:2000.

Keeping the durability and structural requirements, the proposed Compressive Strength of structural concrete at 28 days, for various structural elements/members are as indicated in the below table

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Structural Elements		Compressive Strength at 28 days	Concrete grade
Minimum grade of concrete for any structural member is considered as		35 N/Sq.mm	M35
All Structural concrete for :			
Columns, Shear walls & Core walls	Basement to 4th Floor	50 N/Sq.mm	M50
Columns, Shear walls & Core walls	4th to Terrace	40 N/Sq.mm	M40
Pile and pile cap		30 N/Sq.mm	M30
Beams and slabs	Basement to 4th Floor	35 N/Sq.mm	M35
	4th to Terrace	30 N/Sq.mm	M30
Overhead Water Tank, UG Water Tank, STP & Pump room		30 N/Sq.mm	M30

8.2 Reinforcement

All reinforcement shall confirm to IS: 1786-2008 having minimum yield strength of 550 N/sq mm (Fe 550).

Youngs' Modulus (Es)	200,000N/Sq.mm
Yield Stress (fy)	550 N/Sq.mm
Diameters {in mm} (d)	8, 10, 12, 16, 20, 25 & 32
Density ('Y)	78.5 kN/cum

9.0 DESIGN OF LOADINGS

9.1 Material Density

Unit weight of materials are as per IS: 875 (Part-I) 1987.

Unit weight of concrete	-	25 KN / Cum.
Unit weight of steel	-	78.5 KN / Cum.
Screed concrete	-	24 KN / Cum.
Unit weight of dry soil	-	18 KN / Cum.
Unit weight of saturated soil	-	20 KN / Cum.
Unit weight of Glass	-	27.2 KN / Cum.
Unit weight of water	-	9.81 KN / Cum.
Aerated block masonry	-	8.65 KN / Cum.

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Light weight concrete filling	-	16.0 KN / Cum (Supplier - Nuvoco)
Block wall	-	22 kN/m3

9.2 Superimposed Dead Loads and Live Loads

The following are the imposed loads such as SDL and LL to be considered for the design of floor system depending usage floor. In addition to these loads, self-weight of structural elements will be considered depending member sizes shown in the floor plans.

Usage	SDL (kN/m2)				LL (kN/m2)
	Partition Wall	Services	Finishes	Total	
Bedroom/Kitchen	0.00	0.00	1.20	1.20	2.00
BALCONY/LOBBY	0.00	0.00	1.80	1.80	3.00
CAR PARKING	0.00	0.00	2.9	2.90	3.00
CLUB HOUSE/GYM	0.00	0.00	3.60	3.60	5.00
ELECTRICAL ROOM	0.00	0.00	10.40	10.40	0.00
LANDSCAPE	0.00	0.00	11.70	11.70	3.00
TOILET	0.00	0.00	2.00	2.00	5.00
FIRETRUCK LOAD	0.00	0.00	7.20	7.20	15.00
LMR	0.00	0.00	20.00	20.00	0.00
SWIMMING POOL	0.00	0.00	7.20	7.20	15.00
DG	0.00	0.00	10.00	10.00	5.00
OHT	0.00	10xWater Height	2.4	2.40	15.00

* (G) - Ground floor (OHT) - Over Head Tank
(LMR) - Lift Machine Room

Permissible reduction in imposed load on each floor is considered for design of columns and footings as per IS 875 Part (2).

a) SUPER IMPOSED DEAD LOADS (kN/m^2)

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Floor Finishes of 75 mm thickness have been considered on all the typical floors, Basement floors 100mm, toilet 100+40=140mm, and office-75mm.

TERRACES (Load in kN/m2)

Waterproofing + Screed 3.60 (0.15(average floor finish.) x 24=3.60)

b) SELF-WEIGHT OF LIGHT WEIGHT WALLS (kN/m^2)

Infill walls (20mm for External wall & internal wall 15mm plastering on Either side)

(i)	200mm thick light weight block wall	2.9kN/m2
(ii)	100mm thick light weight block wall	1.77kN/m^2
(iii)	Block Wall (200mm)	4.40kN/m2
	Water Tank	Water height x 10

9.3 Seismic Design Parameters:

Design of lateral force under seismic condition shall be as per IS1893 – 2016. Total lateral force (base shear) of the building shall be estimated at ground floor level as per clause 7.2.1 of IS1893 – 2016 which provides by

Base shear Vb = Ah W

Ah is horizontal seismic coefficient and W is seismic weight of the building, Horizontal seismic coefficient depends on location of the building (Zone factor Z), usage of the building (Importance factor, I), building lateral resisting system (Response reduction factor, R) and design acceleration coefficient (Sa /g) which is based on subsoil condition and fundamental natural period (Ta).

For the proposed development is for commercial use. Considering it, the seismic weight is summation of total dead load and 25% of live load where live load is equal and less than 3 kN/sq.m and 50% of live load greater that 3 kN/sq.m

1) The lateral load resisting system of the buildings are Dual system. The structural shear walls and the vertical elements & beams are design for lateral load.
2) The lateral load resisting system of the buildings is "Dual System" – All the frames are designed as ductile.
3) As per IS 1893:2016 code, Chennai lies in Zone III with Zone factor Z = 0.16

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4) The Design Base Shear is given by V_b = Ah x W, Where Ah = Z / 2 x I/R x S_a/g

I = Importance Factor = 1.2

Soil Type 1 (Rock or Dense soil)

R (Response reduction factor) = 4 (Ductile Shear Wall System)

Sa/g = Average Response acceleration coefficient

For the building height with reference to IS: 1893-2016, since the buildings are well connected with basement walls so for the time period calculation the heights are considered ground floor to roof that is 37.20m.

With reference to IS 1893 - 2016 clause 7.6.2 (b) the time period for building each directions are as follows,

The fundamental natural period (Ta) for building,

b) Buildings with RC structural walls:

$$T_a = \frac{0.075h^{0.75}}{\sqrt{A_w}} \geq \frac{0.09h}{\sqrt{d}}$$

where A_w is total effective area (m^2) of walls in the first storey of the building given by:

$$A_w = \sum_{i=1}^{N_w}\left[A_{wi}\left\{0.2+\left(\frac{L_{wi}}{h}\right)^2\right\}\right]$$

where

h = height of building as defined in 7.6.2(a), in m;

A_{wi} = effective cross-sectional area of wall i in first storey of building, in m^2;

L_{wi} = length of structural wall i in first storey in the considered direction of lateral forces, in m;

d = base dimension of the building at the plinth level along the considered direction of earthquake shaking, in m; and

N_w = number of walls in the considered direction of earthquake shaking.

The value of L_{wi}/h to be used in this equation shall not exceed 0.9.

where,

Base Dimension along X Direction, dx = 20.55m (Longer length)

Base Dimension along Y Direction, dy = 39.50m (Longer length)

H = 42m

T_a = 0.853 sec (along X direction)

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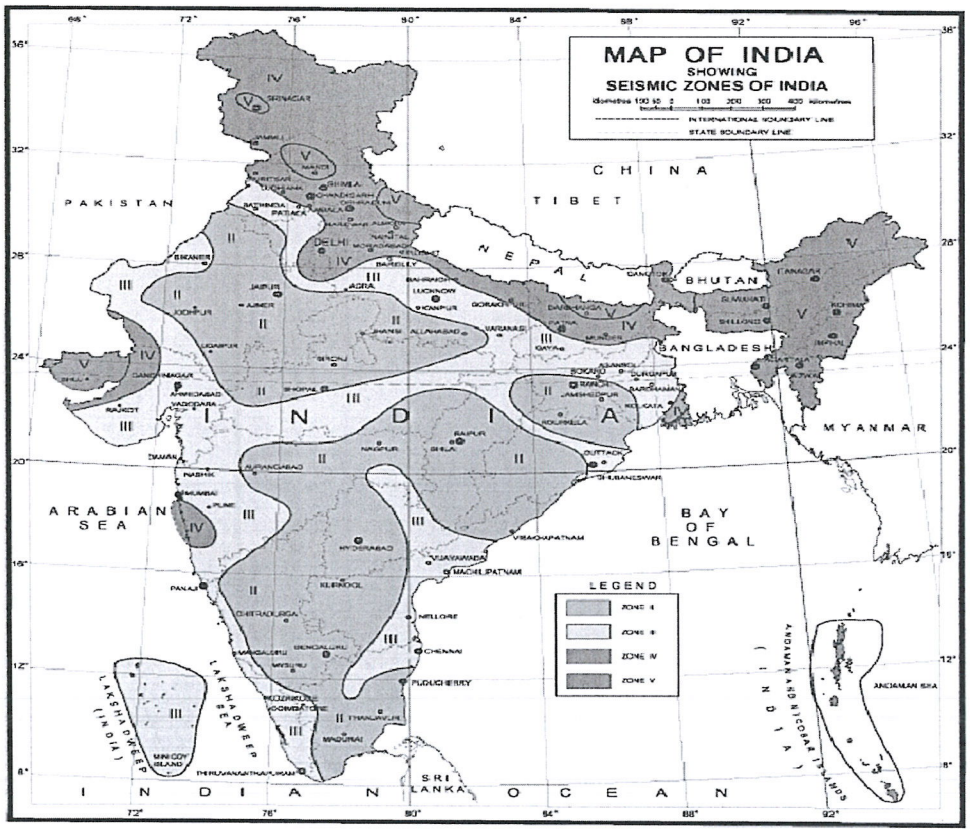
T_a = 1.069 sec (along Y direction)



SEISMIC ZONE CLASSIFICATION FROM IS 1893: 2016

Dynamic Analysis

Response spectrum method of Dynamic Analysis carried out with following parameters pertaining to dynamic analysis.

Number of modes Considered : 12 Numbers (Min)
Modal Combination Method Used : Complete Quadratic combination (CQC).
Directional Combination Method used : Square root of the sum of Square (SRSS).
Modal case type : Ritz vector Method
Cut off frequency in case response spectrum method of analysis - 33 Hz.
Mass participation is 90% as per our analysis
Damping 5%is used for seismic analysis
Dynamic analysis of building is carried out. The members are designed accordingly.

9.5 Wind Loads

The wind pressure shall be calculated based on the basic wind speed and other provisions laid in IS 875 Part (3) - 2015

Design Wind Speed, VZ			= Vbxk1x k2x k3x k4
Vb	→	Basic Wind velocity for Chennai	= 50m/s
K1	→	Risk coefficient for all general buildings	= 1.00
k2	→	Terrain category 2	= To suit the height of the structure for terrain
k2		(H=37.20m -GF to Roof)	= 1.164
k3	→	Topography factor	= 1.00
k4	→	Importance Factor for cyclonic Region	= 1.00

Based on the above,

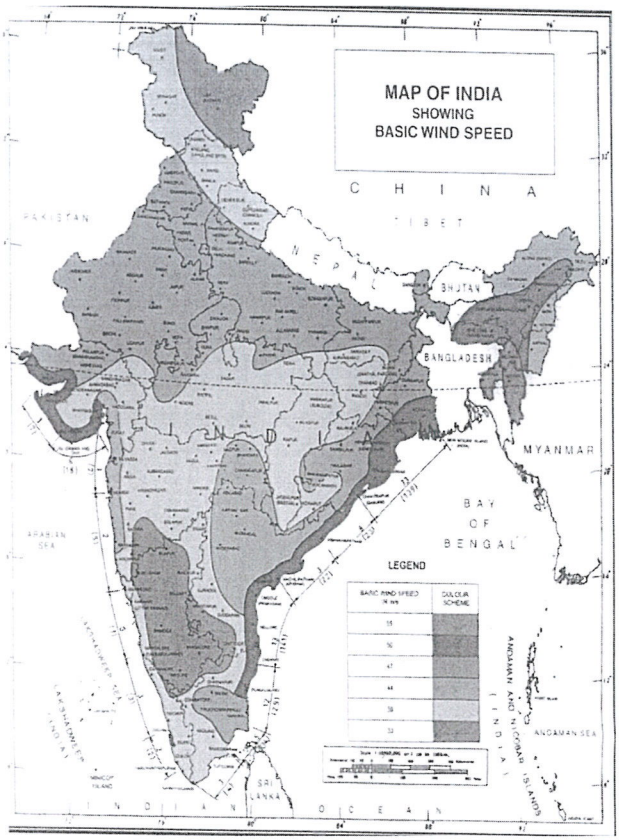
Max. design wind speed (VZ) (Vbxk1x k2x k3x k4) = 58.2m/s

Max. design wind pressure (Pz) = 0.6 x Vz^2 = 2032.344 N/m2

Design wind pressure: pd = Pz x Kax Kd x Kc

= 1481.57 N/m2

Kd	→	Wind directionality factor	= 0.90
ka	→	Area averaging factor	= 0.90
Kc	→	Combination factor	= 0.90



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INDIAN WIND SPEED CLASSIFICATION FROM IS 875 PART (III)

9.6 Temperature Loads:

The building is completely covered with block work on the sides. So there will be no appreciable differential temperature during the service life of building. The roof slab and the podium of building is to be analyzed for ± 15°C difference in temperature is applied to Etabs model and necessary load combinations are considered in analysis & Design of the building. The roof slab is assign as semi rigid diaphragm for ultimate load combination.

10.0 LOAD COMBINATION

The various loads combinations used for design in accordance with IS 1893-2016 are as follows:

1. 1.5 (DL + LL)
2. 1.2 (DL + LL + SPECX)
3. 1.2 (DL + LL + SPECY)
4. 1.2 (DL + LL ± WindX)
5. 1.2 (DL + LL ± WindY)
6. 1.5 (DL + SPECX)
7. 1.5 (DL + SPECY)
8. 1.5 (DL ± WindX)
9. 1.5 (DL ± WindY)
10. 0.9 DL + 1.5SPECX
11. 0.9 DL + 1.5SPECY
12. 0.9 DL ± 1.5WindX
13. 0.9 DL ± 1.5WindY

Load Combination for foundation sizing

14. DL+LL
15. DL+LL+SPECX
16. DL+LL+SPECY
17. DL+SPECX
18. DL+SPECY
19. DL+LL±WX
20. DL+LL±WY
21. DL±WX
22. DL±WY

The various service loads combinations of structure as per IS 456 are as follows

23. 1.0DL +1.0 LL
24. 1.0DL + 1.0SPECX

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25. 1.0DL + 1.0SPECY
26. 1.0DL ± 1.0WindX
27. 1.0DL ± 1.0WindY
28. 1.0DL ± 1.0TEMP
29. 1.0DL + 0.8LL + 0.8SPECX
30. 1.0DL + 0.8LL + 0.8SPECY
31. 1.0DL + 0.8LL ± 0.8WindX
32. 1.0DL + 0.8LL ± 0.8WindY

Where,

DL	- Dead load,
LL	- Live load
Wind X	- Wind load in x - direction
Wind Y	- Wind load in y-direction
SPECX	- Earthquake load in x-direction
SPECY	- Earthquake load in y-direction
AL	-Accidental Load (such as fire tender load)

11.0 SERVICIBILITY LIMITS

11.1 Lateral Deflection (Wind)

Overall Deflection	<	Height/500
Storey Deflection	<	Storey height/500

11.2 Lateral Deflection (Seismic)

Overall Drift	<	H / 250
Storey Drift	<	0.004 times storey height

11.3 Vertical Deflection of Beams and Slabs due to Gravity Loads

Total Deflection (DL + LL) < Span/250

Deflection including the effects of Temperature, Creep and Shrinkage Occurring after erection of partitions and the application of finishes < Span/350 or 20mm whichever is less.

12.0 STRUCTURAL ANALYSIS AND DESIGN APPROACH

Computer-aided analysis using finite element method (FEM) shall be carried out for the design of structural elements. For 3D or 2D structural frame analysis latest version of software ETABS or SAFE shall be used, Prokon, RCDC calculations for manual design of elements and verified in-house spreadsheets will be used for the design of reinforced concrete (RC) and steel elements in consideration of flexure, shear and axial forces.

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Assumptions for 3D model analysis using ETABS

Column: Frame Element
RC Wall: Wall (Shell) Element
Beam Element: Frame Element
Slab: Shell Element

The following are general parameters adopted in the analysis and design,
Modulus of Elasticity of Concrete -5000$\sqrt{}$fck
Consideration of Diaphragm - Semi Rigid Diaphragm.
Slab/Wall element considered as Shell element

Stiffness modification factors are adopted in the analysis as per IS -16700-2023, Table.5.

Table 5 Cracked Section Properties of RC members

(*Clauses* 5.5.2,7.3.6, 8.1.3.2.1 *and* 7.2)

Sl No.	Structural Element	Serviceability Design		Strength Design	
		Cross-Sectional Area	Moment of Inertia	Cross-Sectional Area	Moment of Inertia
(1)	(2)	(3)	(4)	(5)	(6)
i)	Slabs	$1.0A_g$	$0.35I_g$	$1.00A_g$	$0.25\ I_g$
ii)	Beams	$1.0\ A_g$	$0.7\ I_g$	$1.00\ A_g$	$0.35\ I_g$
iii)	Columns	$1.0\ A_g$	$0.9\ I_g$	$1.00\ A_g$	$0.70\ I_g$
iv)	Walls	$1.0\ A_g$	$0.9\ I_g$	$1.00\ A_g$	$0.70\ I_g$

The following parameters and methods are adopted in creating ETABS 3D model for the buildings and design of structural elements.

- ✓ The 3D ETABS model generated based on the preliminary floor plans (shuttering drawings) prepared using preliminary sizes.
- ✓ Sectional properties are assigned to all the structural elements as per the preliminary floor plans (shuttering drawings).
- ✓ External & Internal in fill wall loads are assigned as uniformly distributed line load on beams and as area load if the wall is intending to distribute on slab directly.
- ✓ Slabs are modelled as shell element if floor system and slabs are assigned with horizontal diaphragms.
- ✓ Live Load reduction is considered in the design of Foundation and Column as per the Code: IS 875-1987 (Part-II), clause.3.2.1.

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- ✓ Area design load i.e. Live load/SDL or any other load is applied at floor relevant to its usage.
- ✓ All lateral loads & parameters are assigned as per Codes IS 1893-2016 & IS 875-Part-3, 2015.
- ✓ Beams under Torsion is required to maintain Equilibrium will be designed for Torsion in accordance with IS 456-2000, clause 41.1 to 41.4 and for all other beams torsional stiffness is neglected in the analysis by applying stiffness modifier as 0.000001 to torsional constant "J". Hence no specific design for Torsion is required for these beams.
- ✓ Concrete cover to reinforcement complied accordance with IS 456-2000, Table.16 & 16A.
- ✓ All vertical wall elements are assigned with auto meshing/manual messing appropriately in order to achieve accuracy in results.

Design approach of structural elements

Shear wall/Column:
RC Structural Walls & Columns which are supporting both vertical loads and lateral forces are designed for the most adverse load conditions and envelope of the forces which will be the maximum for that structural element from the load combinations considered in the 3D Etabs Model.
RCDC a design software will be used to design the element for the maximum forces obtained from the Etabs model analysis results.

Beams: Each Beam will be designed for maximum forces from the 3D analysis using Etabs and RCDC Softwares.
Area Load & Application: Applied as uniformly distributed area load with intensity proportionate to its usage as mentioned in the Loading items in the DBR.
Line (Wall) Load & Application: Non load bearing or infill wall loads are calculated appropriate and Applied as uniformly distributed line load.

13.0 COMPUTER PROGRAMS

The following Software / spreadsheet to be used to carry out Structural analysis and design.

1.	PROKON Ver 2.3	- Wall & Beam design
2.	ETABS Ver 19.1	- Three Dimensional Program
3.	SAFE Ver 20.0	- Combined pile cap
4.	In-House Spreadsheet	- one way/ two way slab design
5.	Rapt-6	- Post Tensioning Analysis & Design
6.	RCDC	- Beam Design, Isolated footing design, Column design and Wall design
STAAD PRO & ETABS		- Structural Steel Design.

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This chapter provides design data and results.

1.1 Concrete Frame Design

ETABS Concrete Frame Design

IS 456:2000 Column Section Design (Envelope)

Column Element Details (Envelope)

Level	Element	Unique Name	Section ID	Length (mm)	LLRF	Type
2ND	C58	2	C 450X600	3000	0.5	Ordinary Frame

Section Properties

b (mm)	h (mm)	dc (mm)	Cover (Torsion) (mm)
450	600	60	30

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
35355.34	50	1	550	415

Design Code Parameters

γ_c	γ_s
1.5	1.15

Longitudinal Reinforcement Design for P_u - M_{u2} - M_{u3} Interaction

Column End	Rebar Area mm^2	Rebar %
Top	2160	0.8
Bottom	2160	0.8

Design Axial Force & Biaxial Moment for P_u - M_{u2} - M_{u3} Interaction

Column End	Design P_u kN	Design M_{u2} kN-m	Design M_{u3} kN-m	Station Loc mm	Controlling Combo
Top	3237.269	4.5156	-80.2843	2400	1.5D+1.5SPEC-Y
Bottom	3261.5618	181.1698	101.1363	0	1.5D+1.5SPEC-Y

Shear Reinforcement for Major Shear, V_{u2}

Column End	Rebar A_{sv} /s mm^2/m	Design V_{u2} kN	Station Loc mm	Controlling Combo
Top	498.8	17.6921	2400	0.9D -1.5 WY
Bottom	498.8	17.6921	0	0.9D -1.5 WY

Shear Reinforcement for Minor Shear, V_{u3}

Column End	Rebar A_{sv} /s mm^2/m	Design V_{u3} kN	Station Loc mm	Controlling Combo
Top	665.06	9.3306	2400	0.9D -1.5 WY
Bottom	665.06	9.3306	0	0.9D -1.5 WY

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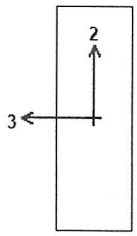
ETABS Concrete Frame Design(TVB7)

IS 456:2000 Beam Section Design (Summary)



Beam Element Details

Level	Element	Unique Name	Section ID	Combo ID	Station Loc	Length (mm)	LLRF	Type
7TH	B4	2106	B 200X600 M30	ENVELOP	800	3200	1	Ordinary Frame

Section Properties

b (mm)	h (mm)	b_f (mm)	d_s (mm)	d_{ct} (mm)	d_{cb} (mm)
200	600	200	0	45	45

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
27386.13	30	1	550	415

Design Code Parameters

γc	γs
1.5	1.15

Factored Forces and Moments

Factored M_{u3} kN-m	Factored T_u kN-m	Factored V_{u2} kN	Factored P_u kN
75.9311	0.0004	88.6141	-18.5777

Design Moments, M_{u3} & M_t

Factored Moment kN-m	Factored M_t kN-m	Positive Moment kN-m	Negative Moment kN-m
75.9311	0.001	75.9321	0

Design Moment and Flexural Reinforcement for Moment, M_{u3} & T_u

	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²

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	Design -Moment kN-m	Design +Moment kN-m	-Moment Rebar mm²	+Moment Rebar mm²	Minimum Rebar mm²	Required Rebar mm²
Top (+2 Axis)	0		172	0	19	172
Bottom (-2 Axis)		75.9321	316	316	19	172

Shear Force and Reinforcement for Shear, V_{u2} & T_u

Shear V_e kN	Shear V_c kN	Shear V_s kN	Shear V_p kN	Rebar A_{sv} /s mm²/m
88.6141	43.0523	45.5652	39.0788	227.5

Torsion Force and Torsion Reinforcement for Torsion, T_u & V_{U2}

T_u kN-m	V_u kN	Core b_1 mm	Core d_1 mm	Rebar A_{svt} /s mm²/m
0.0011	88.6141	130	530	0

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ETABS Shear Wall Design

IS 456:2000 Pier Design

Pier Details

Story ID	Pier ID	Centroid X (mm)	Centroid Y (mm)	Length (mm)	Thickness (mm)	LLRF
STILT	P25	13425	16101.9	1000	300	0.5

Material Properties

E_c (MPa)	f_{ck} (MPa)	Lt.Wt Factor (Unitless)	f_y (MPa)	f_{ys} (MPa)
35355.34	50	1	550	415

Design Code Parameters

Γ_S	Γ_C	IP_{MAX}	IP_{MIN}	P_{MAX}	MinEcc Major	MinEcc Minor
1.15	1.5	0.04	0.0025	0.8	Yes	Yes

Pier Leg Location, Length and Thickness

Station Location	ID	Left X_1 mm	Left Y_1 mm	Right X_2 mm	Right Y_2 mm	Length mm	Thickness mm
Top	Leg 1	12925	16101.9	13925	16101.9	1000	300
Bottom	Leg 1	12925	16101.9	13925	16101.9	1000	300

Flexural Design for P_u, M_{u2} and M_{u3}

Station Location	Required Rebar Area (mm^2)	Required Reinf Ratio	Current Reinf Ratio	Flexural Combo	P_u kN	M_{u2} kN-m	M_{u3} kN-m	Pier A_g mm^2
Top	750	0.0025	0.0026	1.2D+1.2L+1.2SPEC-XW	106556.5791	5.3228	3.8006	300000
Bottom	750	0.0025	0.0026	1.2D+1.2L+1.2SPEC-XW	-107316.1497	-148.5576	3.8339	300000

Shear Design

Station Location	ID	Rebar mm^2/m	Shear Combo	P_u kN	M_u kN-m	V_u kN	V_c kN	$V_c + V_s$ kN
Top	Leg 1	750	1.5D+1.5SPEC-YW	3536.8383	171.9928	-78.262	108	324.5217
Bottom	Leg 1	750	1.5D+1.5SPEC-YW	3578.451	69.3218	-78.262	108	324.5217

Boundary Element Check

Station Location	ID	Edge Length (mm)	Governing Combo	P_u kN	M_u kN-m	Stress Comp MPa	Stress Limit MPa
Top–Left	Leg 1	300	0.9D + 1.5SPEC-XW	2928.9645	-34.262	10.45	10
Top–Right	Leg 1	300	1.5D+1.5SPEC-XW	4441.1124	198.8253	18.78	10
Bottom–Left	Leg 1	300	1.5D+1.5SPEC-XW	4482.7251	-186.7114	18.68	10
Botttom–Right	Leg 1	300	1.5D+1.5SPEC-XW	4482.7251	113.7485	17.22	10

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DESIGN OF SLAB : **TS9**

Panel Name : Three edges; one longer edge discor Code : 14

Clear Longer span, ly = 2950 mm

Clear Shorter span, lx = 2650 mm

ly / lx = 1.11 < 2, Hence, Twoway slab.

Effective Longer span = 3046.00 mm

Effective Shorter span = 2746.00 mm

Assume thickness of slab = 125.00 mm

Effective depth available = 96.00 mm

Loads :

Dead Load and Imposed Load (fixed) :

Floor finish = 1.200 kN/m^2

Self weight = 3.125 kN/m^2

w_{DL} = 4.325 kN/m^2

Imposed Load (Not fixed) :

Occupancy classification as per IS: 875(Part 2) - 1987 :

Live load = 2.000 kN/m^2

w_{LL} = 2.000 kN/m^2

Total load, $w = w_{DL} + w_{LL}$ = 6.325 kN/m^2

Span Moments:

Along Shorter span: BM = $\alpha_x w l_x^2$ = 0.049 x 6.33 x 2.746^2 = 2.31 kNm M_{ux1} = 3.47 kNm

Along Longer span: BM = $\alpha_y w l_x^2$ = 0.043 x 6.33 x 2.746^2 = 2.05 kNm M_{uy1} = 3.08 kNm

Support Moments:

Along Shorter span: BM = $\alpha_x w l_x^2$ = 0.065 x 6.33 x 2.746^2 = 3.09 kNm M_{ux2} = 4.63 kNm

Along Longer span: BM = $\alpha_y w l_x^2$ = 0 x 6.33 x 2.746^2 = 0.00 kNm M_{uy2} = 0.00 kNm

Check for section :

Factored Max. BM, Mu = 4.63 kNm / m

For M35 grade concrete & Fe550 grade steel , Mu, lim / bd^2 = 4.829

Effective depth required = 30.96 mm < Effective depth available, OK

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Along the Shorter span

A_{st} reqd at midspan :

$A_{st} = [\,0.5 f_{ck}/f_y\,]\,\{1 - \sqrt{(\,1 - [4.6\,M_{ux1}/(f_{ck}\,bd^2)]\,)}\}\,b\,d =$ 76.53 mm^2/m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2/m OK

A_{st} reqd at support :

$A_{st} = [\,0.5 f_{ck}/f_y\,]\,\{1 - \sqrt{(\,1 - [4.6\,M_{ux2}/(f_{ck}\,bd^2)]\,)}\}\,b\,d =$ 102.53 mm^2/m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2/m OK

Along the Longer span

A_{st} reqd at midspan :

$A_{st} = [\,0.5 f_{ck}/f_y\,]\,\{1 - \sqrt{(\,1 - [4.6\,M_{uy1}/(f_{ck}\,bd^2)]\,)}\}\,b\,d =$ 67.75 mm^2/m

Provide 8 mm dia bars @ 200 mm As = 251.33 mm^2/m OK

A_{st} reqd at support :

$A_{st} = [\,0.5 f_{ck}/f_y\,]\,\{1 - \sqrt{(\,1 - [4.6\,M_{uy2}/(f_{ck}\,bd^2)]\,)}\}\,b\,d =$ 0.00 mm^2/m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2/m OK

Min Ast = 0.12% Gross section area = 150 mm^2/m

Distribution steel = 0.5 x (0.12/100) x 1000 x 125 = 75.00 mm^2/m

Provide 8 mm dia bars @ 200 mm c/c As = 251.33 mm^2/m OK

Max Spacing = 3d or 300 mm whichever is less = 288 mm or 300 mm

Check for deflection:

fs = 0.58 x fy x (Ast req/Ast pro) = 97.14 MPa

MF = 1/(0.225+0.00322 fs – 0.625 log 10 (l/pt)) ≤ 2 = 2.000

Type of Slab = Continuous

Effective Shorter span = 2746.00 mm

Basic Value = 40

Allowable l/d = 80.00

Actual l/d = 28.60 Hence OK

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Marking : PC2A

TYPE : 2-Pile Group

Material		Pile (1 = Rect, 2=Circular)		Column (1 = Rect, 2=Circular)	
fcu =	30 N/mm²	Pile type =	2	Col. type =	1
fy =	550 N/mm²	Diameter =	1000 mm	Bc =	300 mm
Cover =	75 mm	Capacity =	4000 kN	Lc =	2000 mm
Reinfocement					
B1 =	25 mm				
B2 =	16 mm				

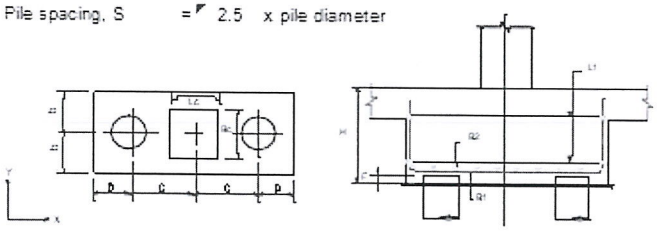
Load factor = 1.5

Ultimate Column Load = 12000 kN

Pilecap Dimensions — Pile spacing, S = 2.5 x pile diameter

B = 650 mm
C = 1250 mm
D = 650 mm
F = 75 mm
H = 1150 mm

L1 = 3T13



Bending Moment & Rinforcement (By bending theory)

Choice of moment - 1 =column face, 2 = center of column [1]

	About Y - Y axis	About X - X axis
Moment arm(mm)	325	
Maximum Moment (kNm)	1950	
Width, b	1300	
Effective depth, d	1063	
$K = M/bd^2fcu$	0.044	
Lever arm, Z	1007	Provide min. reinf't = 0.13%bH
As_{req} (mm^2)	4046 or 3112 mm^2/m	5244 or 1380 mm^2/m
No. of bars & spacing require	9 T 25 @ 141	27 T 16 @ 139
No. of bars & spacing provide	9 T 25 @ 141 (B1)	27 T 16 @ 139 (B2)
As_{prov} (mm^2)	4420 or 3399.7 mm^2/m	5431 or 1429 mm^2/m

Shear Check

Shear force	6000 kN
(100As/bd)	0.32
$(400/d)^{1/4}$	1.00
Allowable shear stress, v_o	0.4064 mm^2/m
Shear span, a_v	25.00 mm
Enhancement factor = 2d/a_v	85.00
Enhanced shear stress (N/mm^2), v_o	4.38 mm^2/m

i) Shear at column face

v = 2.46 < 3.50 ok!

ii) Shear along a vertical section at 20% inside pile across the full width of pilecap

v = 4.34 < 4.38 ok!

iii) Since pile spacing less or equal to 3 x pile diameter, no check is required

iv) Punching shear check

4.1727 Punching Area
8850 Perimeter bo
1.2762 Punching Shear Stress tv
1.3693 Permissible shear stress
O.K

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